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The relationship between the number of sporophylls and the numbers of stamens and pistils—a criticism

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In a paper entitled, "The interrelationship of the number of stamens and pistils in the flowers of *Ficaria*," Harris* has attempted, by statistical methods, to throw some light on the biological factors which determine the sex of an organism. The relative numbers of pistils and stamens present are assumed to indicate which sex is more influenced as the total number of sporophylls increases. Without a knowledge of the number of functional spores that are produced the ratio of the two kinds of sporophylls can hardly be considered as a fundamental measure of the sex of a flower. Nevertheless the quantitative relations between stamens and pistils, if handled so as to be of biological and not purely statistical significance, may suggest more precisely the factors that influence the development of the two sexes.

Harris correlates the deviations of the total number of sporophylls and those of the pistils and stamens from their "probable values." He means by this the average frequency of pistils and stamens to be expected according to the total number of sporophylls. He does this rather than correlate directly with the numbers of pistils and stamens in order to eliminate, as he believes, the spurious correlation which would exist in the latter case. He finds the correlation between the number of sporophylls and the deviation of the pistils from their "probable number" to be of equal magnitude to that of the stamens, but positive, while that of the stamens is negative. From this he concludes that as the number of sporophylls increases, the pistils increase relatively more rapidly than the stamens.

It can be shown that this result necessarily follows from the fact that there are more stamens than pistils while their varia-

* Biol. Bull. **34**: 7–17. 1918.

bilities are almost equal, and consequently has only mathematical and not biological significance.

According to Harris's formula, if $(n + s)$ represents the mean number of sporophylls with their deviations and, let us say, p the percentage of pistils and z_p their deviations from their "probable number" the pistils would be represented by the formula $(n + s)p + z_p$, and the stamens by the formula $(n + s)(1 - p) - z_s$, where z_s is the deviation of the stamens from their "probable number" and $z_s = z_p$. The sum of the pistils and stamens must, of course, equal $(n + s)$, the total number of sporophylls. He then correlates the variables s and z, assuming that z is not contained in s.

We may analyze Harris's formula for pistils to determine which values are known and which are unknown. If n represents the average total number of sporophylls, n_p that of pistils, n_s that of stamens then $n = n_p + n_s$. n_p+x are the pistils with their deviations, $n_s + y$ the stamens with their deviations. The deviation of the total number of sporophylls from their mean, s, equals $x + y$; so that Harris's value for sporophylls $(n + s) = n_p + n_s + x + y$. Since p represents the percentage of pistils, it is equal to $n_p/(n_p+n_s)$, and Harris's value for pistils, given above, becomes

$$(n + x + y)\frac{n_p}{n_p + n_s} + z_p$$

z_p is the only unknown value. We may find its value from the following equation:

$$(n + x + y)\frac{n_p}{n_p + n_s} + z_p = n_p + x,$$

the number of pistils plus their deviation. Solving this

$$z_p = \frac{n_s x - n_p y}{n_p + n_s},$$

$$s = x + y.$$

Therefore, correlating s, the total number of sporophylls, with z_p, the deviation of the pistils from their "probable value,"

$$z_p s = \frac{n_s x - n_p y}{n_p + n_s}(x + y)$$

and averaging

$$[z_p s] = \frac{n_s\sigma_x^2 - n_p\sigma_y^2 + (n_s - n_p)r\sigma_x\sigma_y}{n_p + n_s}.$$

According to Harris's result $[z_p s]$ is always positive. The formula shows that this must be the case when

$$n_s\sigma_x^2 - n_p\sigma_y^2 + (n_s - n_p)r\sigma_x\sigma_y > 0$$

or when

$$n_s(\sigma_x^2 + r\sigma_x\sigma_y) > n_p(\sigma_y^2 + r\sigma_x\sigma_y).$$

If σ_x and σ_y are equal this can happen only when $n_s > n_p$, or in other words when the stamens are more numerous than the pistils.

From the original data from which Harris has drawn the material for this study (see Harris for references) it is evident that the standard deviations for pistils and stamens are nearly equal and that the stamens are more numerous than the pistils. For the average values for Europe given by Pearson the mean number of pistils is 19.432 with a standard deviation of $\pm$ 4.8508; the mean number for stamens 26.498 with a standard deviation of $\pm$ 4.2562. The coefficient of correlation is + 0.5584. Substituting these values we find the results obtained by Harris necessarily follow from the existing numerical relations.

From this consideration it seems evident that the results obtained by Harris do not add anything to the observations on the numbers of pistils and stamens and their variabilities. Just so the higher coefficients of variation given by Harris in Table I of his paper result from the fact that the same value (standard deviation) is divided in the case of the pistils by a lower value (mean for pistils) than in the case of the stamens (mean for stamens).

It might be said that the total number of sporophylls and the per cent of stamens and pistils vary independently, in which case the expression $(n + s)(p + v)$ would represent the number of pistils. Disregarding the value sv, since it is small in comparison to the other values, the expression becomes $p(n + s) + nv$ and the same relations will hold as in the case discussed above.

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